Insights on Water-Ice Partition in Stratiform Mixed-phase Clouds based on Long-term ARCF Observations

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Abstract

Our poor understanding of ice generation in the atmosphere results in large uncertainties in simulating ice and mixed-phase clouds in weather and climate models.

a. Recent analyses on global distribution of mixed-phase cloud distributions and IPCC inter-model differences in simulated cloud radiative forcing under doubling CO_2 condition indicate that mixed-phase cloud representations in climate models contribute significantly to current climate predication uncertainties as shown in figure 1.

b. Challenges exist in simulating water-ice mass partition in stratiform mixed-phase clouds.

c. Using 5-year (1999-2003) multiple-sensor based mixed-phase retrievals at NSA site, we found out:

1: Both Temperature and LWP have strong controls of the water-ice partition.
2: Observations show noticeable seasonal and inter-annual variations.
3: Increase in aerosol loading has impacts on the water-ice partition, especially at low LWPs.
4: The long-term data provide new insights into ice crystal growth in mixed-phase clouds.

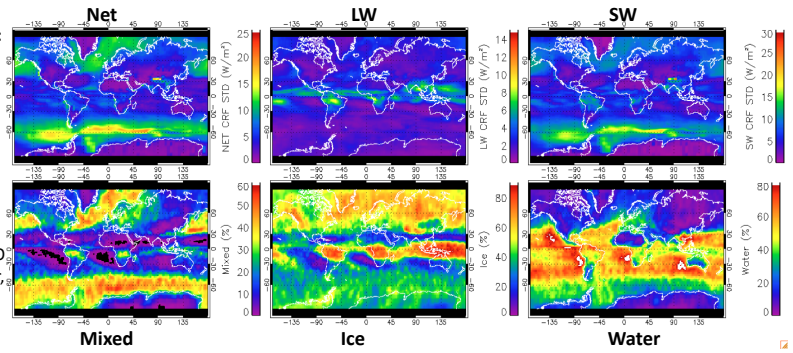


Figure 1: Top row: The spread of TOA cloud forcing changes among 17 coupled GCMs

Bottom row: Cloud phases Distribution from two-year CloudSat/CALISPO data in December, January and February

Challenges in Simulating Water-Ice Mass Partition in Stratiform Mixed-phase Clouds

Klein et al. 2009: multi-model inter-comparison study on stratiform mixed-phase cloud simulations

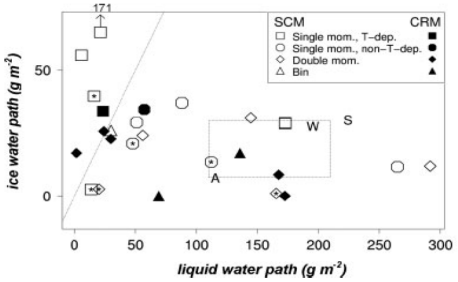
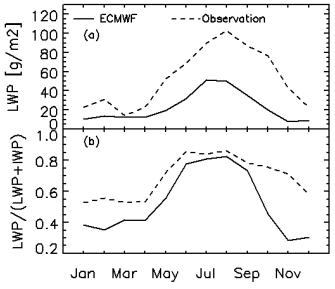


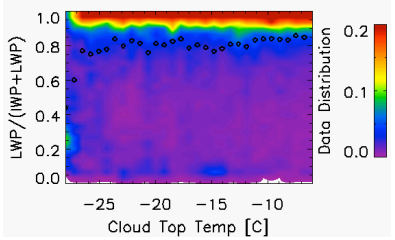
Figure 7. Scatter-plot of the median liquid water path and ice water path from observations (letters) and model simulations (symbols). The

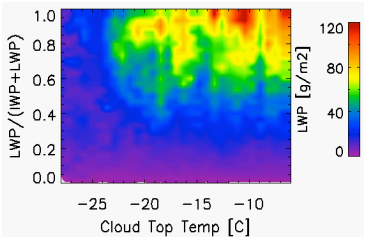
Strong seasonal biases in ECMWF simulations according to five-year observations at the NSA site



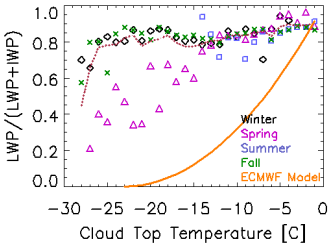
Insights from Long-term Observations at the NSA Site

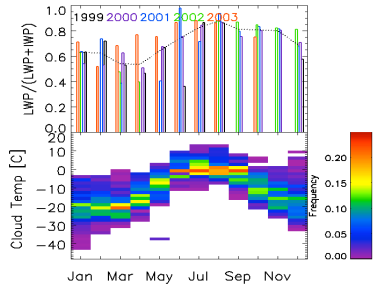
1. Temperature and LWP control the water-ice partition



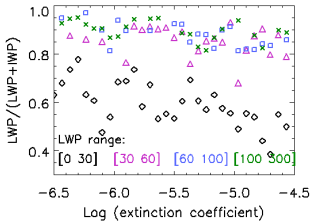


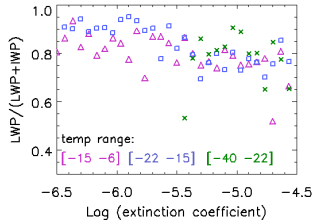
2. Seasonal and inter-annual variations



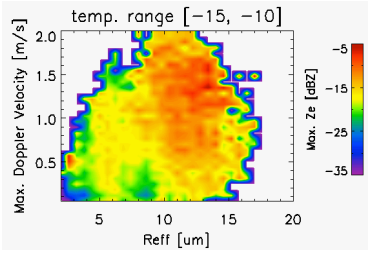


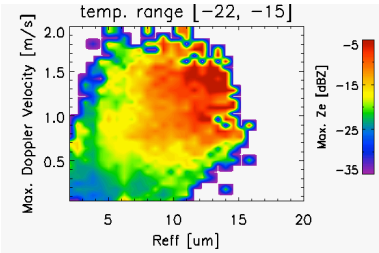
3. Aerosol impacts on the water-ice partition





4. Ice crystal growth in stratiform mixed-phase clouds





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